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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

CLASSES OF MEMBERSHIP

Contributing	$ 5.00 a year	Supporting	$ 25.00 a year
Sustaining	$10.00 a year	Sponsoring	$100.00 a year
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Arboretum Activities

THE STAFF

On Wednesday, August 17th, the Director attended the annual meeting of the American Association of Botanical Gardens and Arboretums which was held in Boston, Mass. This session coincided with the meetings of the National Shade Tree Conference which took place at the same place from August 15th to 18th.

Dr. Patricia Allison addressed the first autumn meeting of the local chapter of the American Rhododendron Society which was held at the Arboretum on September 8th. The subject of her talk was, "Petal Blight of Azalea."

THE SUMMER COURSES

For the sixth successive year the Arboretum presented graduate-level instruction as an integral part of the Summer School of the University of Pennsylvania.

The Director, aided by members of the Staff, offered a six-weeks course on "Ornamental Woody Plants." Enrolled in this class were twenty-five students, most of whom were high school teachers of biology who were attending the University as participants in the Summer Institute of the National Science Foundation. In addition to learning to identify and recognize

(Continued on Page 47)

The Nature and Functions of an Arboretum

JOHN M. FOGG, JR.[1]

By strict definition an Arboretum is a place where trees are grown – a collection of arboreal species of plants. More broadly speaking, however, an arboretum may, and most of them do, include other ligneous plants, such as shrubs, sub-shrubs and woody vines.

One writer has characterized an arboretum as a kind of dendrological Noah's Ark. In view of the fact that with some kinds of trees, such as willows, poplars, hollies and persimmons, it is necessary to have both male and female specimens, this metaphor is not inappropriate.

The accumulation and maintenance of a representative collection of woody plants hardy in any given area involves considerable time, effort and expense. One may well inquire whether such an investment is justified and whether the benefits which may be derived from such an undertaking are commensurate with the cost.

It occurs to me that one way to obtain an answer to these questions is to ask a many-parted question in return, namely, what does an arboretum mean to the following persons or group of persons? Perhaps the replies to these queries will enable us to comprehend the true nature of an arboretum and to appreciate the multitudinous functions which it performs.

THE BOTANIST

An arboretum is a place where the student of plant taxonomy or systematic botany can see and study a large number of authentically named trees and shrubs from many parts of the world. If the collection is arranged according to some natural system of classification he can compare closely related genera within a family or the various species belonging to a genus. If the representation of a particular genus is sufficiently large he can embark upon monographic studies leading to a better interpretation of specific relationships. If, as is often the case, the arboretum possesses an herbarium and a library, it may well become an important center for taxonomic work on world-wide groups of woody plants.

If the plants in an arboretum are arranged on the basis of habitats, rather than in systematic sequence, a fine opportunity is provided for the student of ecology to observe the effects of such factors as soil, light, temperature and water. He can plot growth rates, determine hardiness, record flowering and fruiting behavior, and observe other seasonal phenomena, such as flush – the tendency of certain species to form a second or third batch of leaves.

For the geneticist an arboretum is a place where pure lines of germ plasm may be maintained, where crosses between species and varieties may be carried out under controlled conditions, where hybridization experiments may be conducted with a view of producing better trees – better in the sense of faster growing, more resistant to disease, or more suited to a particular environment.

The plant pathologist finds in an arboretum fertile ground for studying disease symptoms and pathogenic organisms. Here are growing together plants from many different countries; here the opportunities for the introduction and transmission of new diseases are accentuated; here the need for recognition and control of pathogens is of paramount importance.

Although trees are perhaps not the most suitable subjects for study by the plant physiologist, their growth and development present many fascinating problems. Among these are matters relating to mineral nutrition, transpiration rates, conduction of sap, and pigment changes at times of autumn coloration of foliage.

THE ZOOLOGIST

To the student of animals an arboretum represents a zoological microcosmos. Here, usually within a limited number of acres, may be found a variety of habitats supporting a diversified fauna: burrowing animals, small, and sometimes large, mammals, insects (including butterflies and moths), newts and salamanders, and, of course, birds.

The competition between insect and insect, the relationship between insect and plant – harmful in some cases, beneficial in others – the part played by worms in modifying the chemistry of the soil, all these and many other problems can be ideally studied in the outdoor laboratory which we call an arboretum.

THE BIRD LOVER

No matter how small its area, any collection of trees and shrubs provides cover and a supply of food for bird-life. In an arboretum which

[1] Based upon a talk given on the occasion of the Annual Open House of the Tyler Arboretum at Lima, Pennsylvania on May 22, 1960.

covers many acres these advantages are multiplied many times over, with a corresponding increase in the diversity of species and the number of individuals. If care has been taken to include such food-sources as crab-apples, pyracanthas, and various kinds of bush honeysuckle, certain birds which normally migrate south will linger on through the winter.

If, as is the case at the Morris Arboretum, a considerable area of native woodland is available, conditions are thus provided for studying nesting and feeding habits as well as for observing spring and fall migrations. Our Bulletin has, over the years, carried several articles on the birds which have been recorded within the boundaries of the Arboretum.

The Arborist

The professional student of trees finds much to engage his attention in an arboretum. Here he may observe trees suitable for a wide variety of uses: shade trees, timber trees, pulp trees, ornamental trees, fruit trees and so on. Here he may study the relationship that exists between trees and the soil on which they grow, the exposure to which they are subjected and the amount of protection which they may require. He can learn more than he ever could from books about the height and shape of a mature specimen. Here, too, if scientific work is being conducted, he can see the results of hybridizing and grafting, of careful selection and breeding and of tests on hardiness and of resistance to disease.

Finally, the arborist, if he has an open mind, may learn that the new species of trees which are constantly being added from other climes may be superior to the ones which he has been accustomed to using or recommending.

The Conservationist

Few studies are more essential to the continuation of our way of life than those concerned with the preservation of our renewable natural resources: forests, wild-life, soil and water.

To the conservationist an arboretum, especially if it be a large one, is a place where he may learn how plants are adjusted to their environment and how to work with natural conditions rather than against them. He may learn how plants are propagated, on a small or large scale, for reforestation or other purposes. He may see something of the hygienic methods necessary for the growing to robust maturity of trees and shrubs. He may observe the pests and diseases to which they are subject and how these may be controlled. He may even, on occasion, be able to observe the effects of fire, storm, flood and erosion.

The Nurseryman

To the commercial grower of plants an arboretum has much to offer. It can help him establish the botanical identity of unknown or uncertain species. It can call his attention to newly discovered or recently introduced plants which have met the test of hardiness. It can, and frequently does, provide him either with seeds or with other propagating material of plants which he may wish to grow and distribute.

However, it should be emphasized that this relationship is by no means a one-way street. The nursery itself is frequently a source of origin for new introductions or recently developed hybrids and cultivars. Friendships between arboretums and their nurserymen neighbors are mutually beneficial and should be assiduously fostered.

Another Arboretum

A few botanical gardens and arboretums are so fortunate as to be able to send expeditions to distant places for the purpose of collecting plants to enrich their collections. Others, less favored, must frequently depend upon these larger institutions for the acquisition of novelties by gift or in exchange.

Most arboretums prepare each year a list of available seeds of trees and shrubs. These are distributed to a mailing list which includes all accredited arboretums in this country as well as many foreign ones. My own institution frequently orders as many as a hundred species from lists of seeds offered from other arboretums and botanical gardens throughout the world.

A common practice, also, is to distribute among our colleagues a list of seedlings or rooted cuttings which are ready for distribution. Many of us, when we visit a sister institution, express a desire to possess this or that particular species. We, in turn receive similar requests from those who come to inspect our collections. The pleasure of reciprocation is quite equal to that of receiving something that we have yearned for.

In these ways arboretums help to increase each other's representation of authentic material of known origin. Moreover, by exchanging their publications they aid in the dissemination of botanical and horticultural knowledge.

Industry

Many and varied are the ways in which an arboretum is called upon to render assistance to commercial organizations. The following few examples will illustrate this type of service:

A utilities company is desirous of learning what kinds of low-growing trees might be avail-

able for planting under its overhead lines in order to reduce the cost of pruning. Upon visiting the arboretum its representative discovers that there are several species which meet its requirements.

A large jewelry store wishes to utilize various native trees as a basis for designing new lines of costume jewelry. The arboretum is able to supply them with authentic specimens or illustrative material from which their artists can work.

A biochemist in a research laboratory is studying the differences in respiration rates between the pulp and seeds of various fleshy fruits. A tour of the arboretum reveals a wide range of examples from which he may select his experimental material.

A pharmaceutical concern is interested in assaying the extracts from plants containing alkaloids. The arboretum, with its large representation of native and exotic plants, is in a position to furnish it with a broad spectrum for analysis.

The Landscape Architect

For the professional landscape architect a broad knowledge of plant materials is a fundamental necessity. Plants are the basic elements of his design and the more kinds he knows and understands the richer and more varied his palette will be. In addition to becoming acquainted with a large number of trees, shrubs, vines and herbaceous plants, he should understand something of their soil, temperature and moisture requirements, their mode of growth and their size and aspect when fully grown. It is incumbent upon him, for example, to realize that a mature Sawara Cypress may achieve a height of 70 to 80 feet and not to plant one where a smaller species is desired.

There is no better place for a student of landscape architecture to learn these lessons than in a well stocked arboretum. Here he may see many hundreds of woody plants growing under ideal conditions. He may see rich collections of conifers, broad leaved evergreens, deciduous trees and ornamental shrubs and vines. He may come to realize that of 70 different honeysuckles, 60 maples, 50 barberries, 45 viburnums, 30 cotoneasters and scores of hollies, certain varieties are more suitable for given locations than others. He will soon learn that even among the species of a single genus there may be a wide diversity in growth habit, time of flowering, and color and texture of the leaves.

For several years there has been a close working relationship between the Morris Arboretum and the Department of Landscape Architecture of the University of Pennsylvania. Classes from the school visit the Arboretum every month of the year and during the six weeks of the University's Summer School they attend a course which is given at the Arboretum all day long five days a week. The major attention of this course is devoted to the identification and recognition of a selected group of about 200 species of trees and shrubs. In addition to learning the botanical characteristics of these plants, the students sketch the living specimens for the purpose of recording their form, mode of branching and type of foliage. Furthermore, they receive instruction in the principles of ecology, so that they come to understand the importance of those fundamental factors which determine the growth of plants. They are also given lectures and demonstrations in the recognition and control of plant diseases and in the techniques of plant propagation.

The end-product of this program is the turning out of a group of practicing landscape architects with a better understanding of plant materials than would be possible in the absence of such facilities.

The Teacher

For the science teacher an arboretum represents an additional educational facility—an outdoor laboratory or classroom provided at no extra cost.

Most arboretums, especially those close to metropolitan centers, are visited each year by large numbers of students from lower grade to upper high school levels. By busload or cavalcade of private cars they invade the grounds, divest themselves of some of their pent-up energy, and learn something about trees and shrubs from many parts of the world. Many of these youngsters have never before seen a tree or a lawn and years later some of them have told us what a new world their visit to the Arboretum opened to them.

For the college student of botany or biology an arboretum performs an indispensable function. Classes from the University of Pennsylvania visit the Morris Arboretum as a regular part of their course work and many other institutions of higher learning in this region avail themselves of our facilities.

Our Associates

As is the case with most of our sister institutions, the Tyler and the Morris Arboretum have a group of friends known as Members or Associates. In our own case the dues paid by these loyal supporters enable us, among other things, to publish our quarterly Bulletin and to purchase books and plants.

In return an arboretum is able to do many things for its Associates. It can hold occasions like this one today which enable its friends to become better acquainted with what is going on. It can respond to their queries concerning plant cultivation and disease problems. It can offer the facilities of its library and herbarium.

In our own case the Associates participate in the annual plant distribution, at which time rare or unusual plants are offered to those who call for them.

The Artist and Photographer

There is truly no time of year when an arboretum is lacking in interest for the painter or the camera fan. Whether it be the outline of conifers against the snow, the rich display of spring colors, the mature foliage of midsummer, or the haunting panorama of autumn hues—at every season, indeed during each month, there is something worthy of being captured and recorded by brush or film.

At the Morris Arboretum many art classes hold regularly scheduled sessions throughout the year. Near many a photogenic spot, such as the Swan Pond or Rose Garden, it is a common sight to see half a dozen easels set up while students in oil or water color work alone or under guidance of an instructor.

For nearly two decades, one of our neighbors has, on a given date each year, taken a picture of his four children in the same location on our grounds. He possesses not only an interesting record of his family's growth from early childhood to adolescence but a kind of time-lapse series of photos of this particular spot.

A collection of pictures is one of an arboretum's most valuable assets. At the Morris Arboretum we have assembled over a span of a few years a set of more than 3,000 colored transparencies. They are used in our teaching programs and for public lectures; they enable us, almost daily, to answer questions concerning the flowering and fruiting dates of a given species; and like our library books they are available to other institutions which may wish to borrow them.

The Horticultural Society

As arboretums find it possible to develop special collections of various groups of plants they are in a position to appeal to the many regional and national ogranizations which welcome an opportunity to visit their exhibits.

Within the last two years the large arboretums in the Philadelphia area have served as hosts for meetings of the American Rose Society; the American Holly Society and the local chapter of the American Rhododendron Society. The last-named organization holds its regular monthly meetings at the Morris Arboretum, with occasional meetings or field trips scheduled to the Tyler Arboretum, The Scott Foundation and other institutions in the Philadelphia area.

Few arboretums can hope to have complete collections of all genera of woody plants. There is, however, abundant opportunity for each of us to become so strong in our representation of certain groups that we may become a mecca for the enthusiastic devotees of those particular forms. In addition to the ones already mentioned, other groups which come to mind are boxwood, ivy, lilacs, tree peonies and magnolias.

The Garden Club

One of the gratifying developments of recent years has been the increasing use which Garden-Clubs have made of our botanical gardens and arboretums. Frequently this takes the form of a luncheon or dinner meeting, followed by a guided tour of the grounds or an illustrated lecture on a group of plants or some aspect of the Arboretum's activities. On other occasions the session may be devoted to a demonstration of the methods of propagating plants or a practical discourse on the recognition and control of plant diseases.

The verbal and written comments which reach us after these meetings lead us to believe that an arboretum has much to give to organizations of this kind and to entertain the hope that they will continue to avail themselves of our facilities.

The Home Owner

There is perhaps no single area in which an arboretum can make a greater contribution than in the assistance it may render to the owner of a property who is desirous of planting his grounds. This is especially true in the case of someone who has just acquired a newly constructed home on land which may be devoid of trees or shrubs. It may, however, apply equally well to the person who wishes intelligently to augment and improve an existing planting.

When one observes how many homes are surrounded only by Forsythias, Van Houtte's, Spiraea and Kurume Azaleas, it is obvious that there is a crying need for an upgrading of the level of popular taste in the selection of plant materials.

An arboretum is a place where the home owner may see a wide variety of trees, shrubs and vines, authentically named and well grown. It is a place where he may learn that, instead of a single Forsythia, a single Spiraea and a single Azalea there are numerous species and varieties, each adaptable to a given situation. It is a

place where he may see the newer forms of roses, tree peonies and magnolias growing beside the older more traditional ones. He may prefer the latter, but at least he has the opportunity of comparing them and making his own selection.

An arboretum is a place where the prospective planter can learn something of the height and form of mature tree or shrub and accordingly place it in the proper location; where he may obtain information concerning flower color, as well as the time and duration of the blooming period; where he may acquire knowledge as to which plants are truly hardy in his area and which are not, which are subject to disease and what to do about it when symptoms manifest themselves. He may also learn something of the soil requirements of certain plants and what part fertilizers and soil conditioners play in the cultivation of woody plants.

If the arboretum boasts demonstration plantings of vines, ground covers and hedges he may gain valuable information as to the most desirable forms of these special-purpose plants.

The General Public

As our cities expand and their suburbs coalesce, the quest for open space becomes increasingly difficult. As land is divided into smaller and smaller parcels the need to preserve larger and larger natural areas becomes more and more imperative.

The creation and maintenance of parks, public gardens and arboretums therefore emerge as necessities rather than luxuries and it is gratifying to observe that public-minded citizens everywhere are becoming aware of this urgent need. The American Association of Botanical Gardens and Arboretums contains among its member institutions more than seventy botanical gardens and arboretums. Others exist which are not yet affiliated with this organization. Each year witnesses the establishment of one or more new arboretums. Some of these are but small plots of ground with a few trees surrounding a high school; others boast large acreages and imposing endowments. Regardless of their size and the nature of their scientific, educational or aesthetic potentialities, they should be enthusiastically welcomed as bright new stars in our firmament. For, above all, it should be remembered that an arboretum is essentially a garden—a large one, perhaps, but still a garden. As such it provides, in common with all other gardens, a place for meditation, for the enjoyment of nature in its many moods, for walking among shrubs or under trees, for shuffling dead leaves with one's feet in the autumn. These are matters of the human spirit; these are the intangibles which can not be weighed in an ordinary balance; these are, perhaps, the most important attributes of an arboretum.

If, in all of this, I seem to have conveyed the impression that I consider an arboretum to be an integral and indispensable part of our culture, then I have done what I set out to do.

New Associates

The Arboretum is happy to welcome the following new Associates who have enrolled since June 1960:

Mrs. Donald B. Barrows
Misses Boyd and Ott
Mr. and Mrs. Howard Butcher, III
Mrs. Elizabeth de Berardinis
Mr. D. T. Ebert
Mr. Alan L. Emlen
Mrs. T. Bromley Flood
Mrs. Edward J. Garra
Mrs. Betty Gottlieb
Mr. and Mrs. R. L. Gray, Jr.
Mr. and Mrs. Caspar W. Haines
Dr. F. H. Harvie
Mr. M. G. Herbach
Rev. Louis Hetrick
Mrs. Frederica Johnston
Mrs. Crawford C. Madeira
Mrs. Gary Mattke
Mr. J. Don Miller, Jr.
Miss Rose T. Nardone
Mrs. Ezra K. Nicholson
Mr. Walter M. Phillips
Mrs. B. F. Roland
Mrs. Betty Rotenberg
Mr. Kenneth E. Schroder
Mr. Richard K. Stevens
The Upjohn Company
Mr. Louis Wax
Mrs. Casper Wister
Mrs. Julius Zieget
Mr. Charles A. Zittle

Associates' Corner

Progress in the Medicinal Garden

Back in the 16th century practically every important garden in Europe was essentially a collection of drug plants. This was especially true of the monasteries whose gardens were presided over by monks.

We know from the Badianus Manuscript that many plants were used as drugs in Mexico long before the coming of the white man. Throughout the rest of the Western Hemisphere there was a considerable body of medical lore known to the aborigines.

Even in our neighboring Germantown Dr. Witt, friend of the Kelpius band, established in the early 1700's a special medicinal garden with plants imported from Germany and native herbs which he learned about from the Indians.

Today, with the reawakening of interest in plants as the sources of drugs, several American arboretums and botanical gardens have established medicinal gardens. For the most part, however, these collections contain only plants hardy to the north temperate area. Inasmuch as the great majority of the world's drug plants are of tropical origin it is obvious that these collections are far from complete.

When Dr. Fogg became Director of the Arboretum there was a practically unused greenhouse somewhat apart from the other houses. He conceived the plan of using this house for a living collection of some of the more important tropical drug plants. During the summer months these tender plants were moved outdoors to a trial garden along with hardy native species.

In 1957 the Arboretum was awarded the Founders Fund of the Garden Club of America for the purpose of establishing a representative Medicinal Garden. Dr. Fogg was able to enrich this collection with collections of drug plants he had made in Southern Asia, Mexico, Central America and the West Indies.

For many years the American pharmaceutical industry had been experimenting with synthetic drugs, but the fallacy of some of these substitutes was tragically demonstrated when the supply of quinine and other plant drugs was cut off during World War II.

In the Philadelphia Flower Show in March, 1958, the Arboretum exhibited some of the plants from its Drug Plant Garden. The collection included both native and exotic species and each specimen was artistically labeled by Dr. Li. An attractive legend gave the derivation and therapeutic uses of every plant.

This summer the medicinal collection was established in its permanent location in an area formerly occupied by a conifer nursery. This nursery had become so over-grown that most of the specimens were too large to move. A few exceptional ones were given to the Longwood Gardens; most of the others were "rogued out". The Arboretum's Assistant Superintendent, Mr. John Dourley, then proceeded to design a garden with winding walks and informal beds. utilizing some of the better evergreens as focal points and background material. The result of his brilliant planning is a garden lovely in itself aside from its outstanding interest as a collection of drug plants.

Here, in this skilfully contrived garden, are more than 150 species of drug plants, many of which Mr. Dourley has propagated from seeds. They are largely grouped according to their medicinal properties or chemical constituents; e.g., cathartics, narcotics, stimulants etc., or plants containing gums, resins, alkaloids, and the like. One of the most interesting is *Chenopodium ambrosioides* an old established cure for Hook Worm.

This combined indoor and outdoor drug plant display is now open to the public and is attracting considerable interest. It is of special value to the students in the five medical schools in the Philadelphia area as well as to the students of pharmacy. The Arboretum receives frequent requests for seeds or cuttings for experimental research.

The educational potential and scientific importance of this wonderful collection, unique in the United States, should prove of invaluable assistance in furthering the health of our Nation.

Great praise and credit should go to Dr. Fogg, Mr. Dourley, and the other willing workers who have created this garden. They started it in March and it was a going concern by May.

Marion W. Rivinus

The Cultivated Maples

HUI-LIN LI

The brilliant display of colors in the forests and countryside every autumn is a familiar sight to people living in the northeastern part of North America. Few realize, however, that this autumn splendor is restricted to only certain parts of the world. Such colorful scenery is not seen by residents in the tropics, nor in other parts of the temperate world, such as western North America, where the temperature does not fluctuate widely throughout the year. Actually in the entire world, this gay mantle of fall color may be seen only in temperate eastern Asia, eastern North America and parts of central Europe.

In these three areas, the monthly temperature change is pronounced and a more or less severe winter follows a warm summer. At the approach of winter, the deciduous trees prepare themselves for a long resting period. Foods manufactured by the leaves in the form of sugars are transferred to the woody branches or roots for storage, chiefly in the form of starch, for the growing buds next spring. During this process, chemical substances known as anthocyanins are produced in the leaves of many plants. They may appear red when free acids are present in the cell-sap, and blue when there are no acids.

The red color of the autumn leaves is due to these pigments. The color is more intense in some trees than in others. If anthocyanins are associated with yellow compounds, the leaves will assume an orange tinge. The yellow color is due to the yellow pigments normally present in the chloroplasts, the green granules which manufacture food for the plant in the sunlight. In the dying leaves, the green pigment of the chloroplasts disappears and the yellow color thus becomes visible. Eventually the leaves will dry and turn brown. Thus, in autumn coloration, plant foliage displays all gradations from brown to yellow to red.

Among the trees that show the most brilliant color in autumn are many maples, Sweet-Gum (*Liquidambar*), Sassafras, Tupelo (*Nyssa*), Scarlet Oak, Sorrel-tree (*Oxydendrum*), and also some dogwoods, sumacs, viburnums, and other genera. Most of these genera are especially developed in or restricted in their distribution to eastern Asia and eastern North America. Because of its large number of species and their wide distribution the most important genus of all is *Acer*, the maples.

Acer, The Maple Genus

The maples are among the most widely planted shade and ornamental trees. They are used everywhere, along streets, in parks and in gardens. The genus contains trees of such sizes and types as to meet all requirements, and the great variation in size and form of the species and in the shape and color of the leaves is not matched by any other genus. These characters, together with their ease in transplanting and relative freedom from serious pests or diseases, make these trees highly popular for landscaping purposes.

This large genus contains at least 150 species, distributed over a major part of the Northern Hemisphere from Alaska and Siberia southwards. The genus also occurs south of the equator in the islands of southern Asia—in Sumatra, Java, Celebes and Timor (Mulligan, 1958).

The majority of the species occurs in eastern to southeastern Asia, with 69 in China, 16 in Japan, and 9 in southeastern Asia. There are about 7 species in India and Burma to Tibet, 7 in western Asia, and 13 in Europe. In North America, including Mexico and Guatemala, there are altogether 25 species.

About 68 species of *Acer*, with numerous varieties and forms, are in cultivation in North America. Their most important use is as street trees. Other species are used in rock gardens or on lawns. The autumn coloration of the foliage of many species is the most desirable feature for landscaping. Some species also provide colorful foliage for the spring or summer. A number of kinds are valued also for their ornamental bark (Wyman 1959).

Maple for Autumn Coloration

Many species of maples are cultivated primarily for their autumn color. This color varies from red to red and yellow, orange, orange brown and yellow. The commonly cultivated species with these different colorations are listed below:

Red:

Acer capillipes	*A. mandshuricum*
A. Ginnala	*A. nikoense*
A. griseum	*A. palmatum*, many forms
A. japonicum	
A. leucoderme	*A. rufinerve*

A. tataricum 'Rubrum'

Red and/or orange and red:

Acer Buergerianum	*A. rubrum*
A. circinatum	*A. saccharum*
A. cissifolium	*A. spicatum*

Orange or orange-brown:

Acer carpinifolium	*A. palmatum*, some forms
A. macrophyllum	*A. truncatum*

Yellow:

Acer campestre	*A. platanoides*
A. cappadocicum	*A. saccharinum*
A. glabrum	*A. tataricum*
A. Mono	*A. tegmentosum*
A. nigrum	*A. Tschonoskii*
A. pensylvanicum	

Yellow and purple:

Acer Davidii

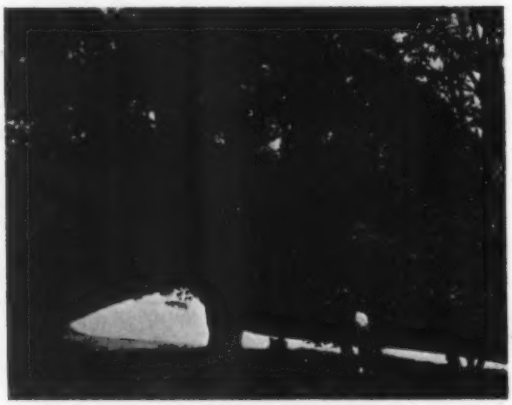

Fig. 30. *Acer palmatum*

Summer Coloration

Besides early spring and late autumn, some maples also provide foliage of varied colors in the normal growing season of the year from late spring through early autumn. A few species are noted for the brightness of their green color, but it is the large number of distinctive colored and variegated forms that are valued for specific ornamental purposes. The greatest variation in color is found in the Japanese Maple, *Acer palmatum*, which we will discuss separately. The following is a list of colored and variegated forms among the other species of the genus.

Colored forms:

Acer Heldreichii	'Purpuratum'	Red beneath
A. japonicum	'Aureum'	Yellow
A. Negundo	'Auratum'	Yellow
A. platanoides	'Rubrum'	Dark Red
	'Schwedleri'	Red beneath
A. pseudoplatanus	'Purpureum'	Purple beneath
	'Worleei'	Deep yellow
A. velutinum	'Wolfii'	Red beneath

Fig. 31. *Acer palmatum*, a dwarf dissected-leaved form

Variegated forms:

Acer campestre 'Variegatum'	Bordered with white
'Albo-variegatum'	With large white blotches
A. Negundo 'Variegatum'	Bordered with white
'Aureo-marginatum'	Bordered with yellow
'Aureo-variegatum'	Spotted yellow

Fig. 32. *Acer Buergerianum*

Fig. 33. *Acer truncatum*

A. platanoides	'Variegatum'	With large white blotches
A. pseudoplatanus	'Flavo-variegatum'	With yellow blotches
	'Variegatum'	With white blotches
A. rufinerve	'Albo-limbatum	Bordered with white dots

The Japanese Maple

The above lists show the great variation in color of the foliage within the genus. Besides color, variation in leaf form in *Acer* is also very great. The leaves vary from unlobed to lobed and finally dissected forms. (Figs. 30, 31).[1]

All these variations, color as well as form, are highly manifested in a single species, *Acer palmatum*. The Japanese Maple is undoubtedly the most variable species, so far as foliage is concerned, of cultivated trees or shrubs. Mulligan (1958) recognizes more than 70 varieties or cultivars of *Acer palmatum* in North America. While in other ornamental plants, especially in herbaceous ones, variation frequently occurs in flowers, here the ornamental feature depends mainly on the leaves, and sometimes also on the shape of the plant.

This great variation is brought out by intensive cultivation and selection in the Japanese garden. The species has been cultivated there since very early times for the brilliant red foliage in autumn so frequently praised in poetry and depicted in paintings. The Japanese call it Takao Maple because it is especially abundant on the mountain Takao, famous since ancient times for autumn coloration. They use it extensively in their gardens and also as potted dwarf trees (Makino 1951).

The Japanese Maple is a shrub or small tree. It is native to Japan and adjacent parts of the Asiatic mainland. In the Japanese literature there are hundreds of named forms, many of which are now also in cultivation in western gardens. The variation may be either in the color or the shape of the leaves or sometimes in a combination of these two characters.

The leaves vary from 5- to 9-lobed. In some forms, such as the 'Palmatum' group, the leaves are more consistently 5-lobed, while in others, such as the 'Septemlobum' group, the lobes may be mostly 7. The lobes are usually deep and in some forms they may be divided all the way to the base of the blade. The individual lobes may be nearly entire along the margins or more commonly coarsely serrate; in others, they are deeply incised. The extreme forms, such as 'Dissectum' and 'Sessilifolium,' with strongly dissected lobes, have a delicate featherly appearance.

Fig. 34. *Acer Miyabei*

[1] Cover illustration and Figs. 31 and 35 by C. E. Pancoast; others by H. L. Li.

Fig. 35. *Acer Henryi*

In color, the leaves vary from bright green to yellow and different shades of red or purple. They turn yellow to orange or red in the autumn. There are also variegated forms with white spots ('Versicolor'), red blotches ('Bicolor'), pink margins ('Roseo-marginatum'), or various other color combinations. A most becoming form is 'Tricolor' which has the leaves spotted red, pink and white.

Other Asiatic Species

Eastern Asia is the center of development of the genus with about 100 or two-thirds of the total species. (Fang 1939, Matsumura 1954). A number of these have long been in cultivation in their native countries. In Japan, besides *Acer palmatum, Acer japonicum* has also been long cultivated. In eastern China, *Acer Buergerianum* has been in cultivation since early times and was also introduced into Japan centuries ago. (Fig. 32). The most commonly cultivated species in northern China are *Acer truncatum* (Fig. 33) and *Acer Mono.*

In the last two centuries numerous other species growing wild in the mountains of China and Japan have been introduced by plant explorers into cultivation. These include some of the most handsome small and medium-sized trees. Some of these have become highly valued in recent years on account of their small sizes and neat appearances, features that are especially desirable for modern landscaping.

From Japan, among the most notable newer introductions are such species as *Acer Miyabei,* (Fig. 34) *Acer rufinerve* and *Acer Tschonoskii. Acer cissifolium* and *Acer nikoense* have 3-foliolate leaves and are related to the American Box Elder. *Acer crataegifolium* and *Acer carpinifolium* are distinctive species with unlobed leaves resembling *Crataegus* and *Carpinus* in appearance, respectively.

From Korea, Manchuria and northern China come such species as *Acer Ginnala, Acer mandshuricum* and *Acer tegmentosum. Acer mandschuricum* is a 3-foliolate-leaved species. These species, originating from a more northern climate, are among the hardiest species in cultivation.

The largest number of new introductions in modern times has come from the mountains of central and western China, the center of development of the maple genus. Among the numerous desirable species, the following are especially notable: *Acer Oliverianum, A. Davidii, A. griseum* and *A. Henryi.* These are all handsome trees mostly of relatively small size. *Acer Davidii* is a very colorful and distinctive looking tree in the autumn with its foliage turning yellow and purple. The white shiny branches are also conspicuous. *Acer griseum,* the Paperbark Maple, is equally distinctive in the winter with its flaky bark. *Acer Henryi* is a 3-foliolate leaved species related to the Box Elder. (Fig. 35).

The species from eastern Asia now in cultivation are too numerous to mention. Most of these are still of restricted planting and are

Fig. 36. *Acer Mayrii*

Fig. 37. *Acer platanoides* 'Erectum'

found only in arboretums and botanical gardens. Some of the other species which deserve listing are *Acer Mayrii* (Fig. 36), *A. sinense, A. diabolicum, A. longipes* and *A. capillipes.*

Species of the Himalayan Region

Species indigenous to the Himalayan region are generally tender and therefore not suitable for the more strictly temperate climates. These often also extend to parts of China and even to Japan, and the forms or races of these latter varieties are hardier than the typical ones from the Himalayan region.

European and Western Asiatic Species

The Norway Maple, *Acer platanoides,* and the Sycamore Maple, *Acer pseudoplatanus,* native to Europe and western Asia, are among the most widely planted trees.

The exact limits of distribution of the Sycamore Maple (*A. pseudoplatanus*) are difficult to define as the tree has been extensively planted for centuries all over Europe. The native habitat seems to extend from the mountain chain of the Pyrenees to the Alps and the Carpathians in the hilly districts of France, Germany, and Italy to Greece, the Crimea and the Caucasus. In other areas in Europe it is extensively cultivated and flourishes as far north as Norway and Sweden (Elwes & Henry 1906).

There seems to be little variation in the foliage in the wild form, but numerous varieties have arisen in cultivation, especially with respect to the shape of the leaves. A few colored and variegated forms are also known. The best known colored form is 'Purpureum', with leaves purple beneath. The petioles and fruits are often bright red. This variety originated in 1828 in Sander's Nursery in Jersey, England. (Elwes & Henry 1906).

The Norway Maple (*A. platanoides*) has a wider distribution, covering most of Europe and extending eastward into the Caucasus, Armenia and northern Persia. It is indigenous in Norway, Sweden and Finland, and is common in Germany, France, northern Spain and northern Italy (Elwes & Henry 1906). In England it is not native but was introduced in 1683 (Loudon 1838).

The Norway Maple is one of the hardiest trees in cultivation and will grow on the driest and poorest soil. It was introduced into North America in 1870 (Rehder 1940) and is now one of the most widely planted street trees. A number of varieties have arisen in cultivation in Europe including the highly ornamental 'Palmatifidum', the Eagle's-claw Maple, with its elegantly dissected foliage, 'Schwedleri' with its colorful leaves, bright reddish when young, changing eventually to dark green, and 'Erectum' a narrow-pyramidal tree with large leaves. (Fig. 37).

The Hedge Maple, *Acer campestre,* of Europe and western Asia, has also been long cultivated, especially in hedge-rows. (Fig. 38). It runs into many forms. Species from the Mediterranean region, such as *Acer orientale, A. Opalus, A.*

Fig. 38. *Acer campestre*

Fig. 39. *Acer rubrum*

monspessulanum, and *A. Heldreichii* are generally suitable for the milder climates. Species from the Caucasian region, such as *Acer Trautvetterii*, *A. velutinum* and *A. tataricum*, are sometimes also not hardy in the colder regions.

Species of Eastern North America

A few species from eastern North America are now widely planted not only in America but also in Europe and other continents. Among these, the most notable are the Box Elder, *Acer Negundo*, and to a lesser extent, the Red Maple, *Acer rubrum*, (Fig. 39), the Silver Maple, *Acer saccharinum*, (Fig. 40), and the Sugar Maple, *Acer saccharum*. (Fig. 41). These species were first cultivated in colonial times in the 17th and 18th centuries.

The Box Elder occupies a wide range from eastern to western North America with several geographical varieties and a number of horticultural forms some of which are now favorite ornamental trees. The species is very hardy and drought-resistant and is much used in the northwestern United States for shelter-belts. It was one of the first North American trees introduced into Europe and was cultivated by Bishop Compton in his garden at Fulham near London before 1688 (Loudon 1838). The variegated-leaved form is now a popular garden plant in most European countries.

The Sugar Maple, the source of maple sugar, is much planted, especially in the northeastern States, as a street and shade tree. Formerly it was considered as a wide ranging and variable species, but those forms outside of northeastern United States are now treated as distinct species such as *A. nigrum*, *A. grandidentatum*, *A. leucoderme*, etc. The Sugar Maple was introduced into England by Peter Collinson in 1735 (Aiton 1789).

The Silver Maple and Red Maple are also widely cultivated as ornamental trees and both species have developed into a number of horticultural forms in cultivation. The Red Maple, as it inhabited swamps close to the coast, attracted the attention of early travelers in America. It was carried to England as early as 1658 and planted near London in the garden of the younger Tradescent (Sargent 1891). The Silver Maple was introduced into English gardens in 1725 by Sir Charles Wager (Sargent 1891). It grows as well in Europe as in its native country and many varieties have been found in both American and European nurseries.

Less commonly planted are such species as *Acer nigrum* (Black Maple), *Acer leucoderme*, *Acer spicatum* (Mountain Maple), and *Acer pensylvanicum* (Moosewood or Striped Maple).

Fig. 40. *Acer saccharinum*

Fig. 41. *Acer saccharum*

Species of Western North America

Species of the western part of North America are generally suitable for the milder climates only. Species that can barely survive in the Philadelphia region include the Oregon Maple, *Acer macrophyllum* and the Vine Maple, *Acer circinatum*. The first is a large tree with very large leaves, attaining to 20-30 cm. across in its native habitat. (See Cover). The latter is a small tree with a wide-spreading habit. The Box Elder, *Acer Negundo*, as mentioned before, is the most widely distributed species of Maple in North America, extending all the way from the eastern to the western part of the continent. There are also local varieties in California, Texas, etc., but these forms are not hardy in colder regions.

The western American species have been cultivated only since the early part of the nineteenth century. Besides those mentioned above, other species are occasionally also planted, such as *Acer grandidentatum*, of the Rocky Mountain area, and *Acer glabrum*, which is widely distributed from Alaska to California.

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Arboretum Activities

(Continued from Page 34)

many of the trees and shrubs in the Arboretum's collections, members of the class received instructions in such subjects as the recognition and control of plant diseases, methods of plant propagation and forest genetics. An essential feature of the course was the daily field trips taken around the grounds or to nearby areas of botanical interest.

A second course, coinciding in time with the first, was given to the group of graduate students in the University's Division of Landscape Architecture. The twelve students in this course not only learned how to identify plants but gained some appreciation of the importance of trees and shrubs as elements in design.

Courses for Associates

Of interest to our Associates in the Philadelphia area will be the news that two popular courses in botany are being offered at the Arboretum this autumn.

For some time we have been contemplating the resumption of both classes and public lectures at the Arboretum. It remained, however, for one of our Associates to take the initiative by organizing the first group, the members of whom attended a series of lectures on Plant Ecology last spring.

The response to this course was so gratifying that we have taken steps to continue and amplify our offerings. The charming little studio on the slope below Gates Hall has been renovated and converted into a class room. Two courses got under way the middle of September; one is devoted to Identification of Flowering Plants, the other is an Introduction to Fungi. Thanks to the number of inquiries which have reached us concerning this type of instruction we are hopeful that we may be able to announce a repetition of these or similar courses next spring.

The implementation of such a program requires the cooperation of the faculty of the Division of Biology, the staff of the Arboretum and our Associates. To date the response has been most encouraging.

Operation Sewer

Visitors to the Arboretum during the summer months were dismayed to observe a deep trench traversing the grounds from the Lodge on Hillcrest Avenue to the Native Azalea planting along the Wissahickon Creek. This project was not of our own making, but represented the construction by the City of Philadelphia of a sanitary sewer and a storm water outlet, both of which were authorized by Ordinance of City Council.

It is a pleasure to be able to report that this construction took place with a minimum of inconvenience to the activities of the Arboretum and that the contractor exercised every possible precaution to avoid injury to existing plantings of trees and shrubs.

J. M. F. Jr.

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Insecticides in the 20th Century Environment[1]

GEORGE C. DECKER[2]

When the first white men came to North America, they found a race of rather primitive men living in reasonable harmony with a relatively stable environment. Under those conditions, this continent supported a population of about one million persons and provided in excess of 2000 acres per capita. Then, as now, literally dozens of insects attacked every crop that grew and neither man nor beast escaped their ravages. In the years that followed, with agriculture on a subsistence basis and a seemingly endless supply of land available, there was plenty for all, and farmers raised only feeble objections to share cropping with the insects. Later, as urban populations increased, each farmer was called upon to meet the food and fiber requirements of an ever-increasing number of individuals and to do so on an ever-decreasing number of acres per capita. This trend continued until at present we have only a little over ten acres per person, seven of which are classified as farm land but only two of which are devoted to crop production.

The early American farmers had little choice but to rely upon nature to control their insect enemies. Then, as losses mounted and the standards of perfection demanded by an increasingly more discriminating consuming public rose, farmers began to clamor for governmental aid and scientific guidance to solve their insect control problems. The early state and federal entomologists were essentially naturalists, and they preached a gospel of biological and cultural insect control methods. For years such measures dominated all entomological endeavor, but finally when natural controls proved wholly inadequate, entomologists reluctantly turned to chemicals, and thus we entered an age of chemical insect control.

THE ADVENT OF INSECTICIDES

The large-scale practical use of insecticides is in reality one of the important technological developments of the 20th century. While it is true that numerous nondescript concoctions of lye, lime, soap, turpentine, brine, vinegar, fish oil, and even some tobacco, pyrethrum powder, mineral oil, and arsenic were reportedly used as insecticides prior to the year 1800, effective use of agricultural insecticides had its origin with the use of Paris green to control the Colorado potato beetle in 1867. For the next seventy-five years, arsenical compounds played an ever-increasing role in insect control. Thus, considering the many insecticidal uses for white arsenic, sodium arsenite, lead arsenate, calcium arsenate, and other arsenical salts, it is not surprising to find that from 1939 to 1948 the domestic consumption of white arsenic averaged over 35,000 tons per year. It must be noted also that the arsenicals were not the only chemicals used as insecticides in the pre-DDT era. To obtain a fair estimate of the extent of insecticide usage in the early 1940's, we would have to add about 15 million pounds of pyrethrum flowers, 8-10 million pounds of rotenone-bearing roots and powders, and at least one million pounds of nicotine. Then to all of this we must add literally millions of gallons of petroleum oils, unestimated quantities of tars, cresols, fish oil, and many lesser products.

With the advent of DDT for agricultural use in 1945 and the large array of chlorinated hydrocarbon and organophosphate insecticides that followed in quick succession, many of the older materials suffered a rapid decline in popularity and they were largely replaced by the more effective synthetic organic insecticides. It appears that the actual tonnage of primary insecticidal chemicals produced for domestic consumption each year may not have changed materially. However, with the use of newer and more effective materials at much lower rates of application, the acreage treated has increased several fold in the last decade. Moreover, while prior to the advent of DDT the use of insecticides was for the most part confined to fruit, vegetable, cotton and a few miscellaneous crops of high-per-acre value, they are now used quite extensively on several field crops, pastures, meadows, and forests.

When DDT and at least a dozen other new chemicals became available for general use, a number of competent and distinguished scientists expressed concern that widespread use of

[1] This article, a condensation from a paper presented at a Symposium sponsored by the Ecological Society of America, appeared in the April 1960 issue of the Bulletin of the American Institute of Biological Sciences. The Director of Publications of that organization kindly granted permission to reprint it here.

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these materials might create a public health problem. Immediately a number of publicity seekers and misguided individuals seized upon the idea that the public was being poisoned, and the country was deluged with an amazing flood of scare stories. Then, as the general public began to show some concern, the witch hunt got underway in earnest. As absurd charges and counter-charges were hurled back and forth in congressional committees and in the press, the scientists settled down to a detailed analysis and factual study of the problem. The public health aspects were reviewed by several scientific bodies, notably the World Health Organization (1, 12), the U. S. Public Health Service (7), and the Food Protection Committee of the National Research Council (4, 6). The general conclusions drawn in each instance were: (a) The large-scale usage of pesticides in the manner recommended by manufacturers or competent authorities and consistent with the rules and regulations promulgated under existing laws would not be inconsistent with sound public health programs, and (b) although the careless or unauthorized use of pesticidal chemicals might pose potential hazards requiring further consideration and study, there was no cause for alarm.

These encouraging conclusions notwithstanding, the fact that insecticides may be misused remains a matter of concern to a considerable segment of the American public. This is true particularly of conservationists who quite correctly insist that many forms of wildlife are subjected to certain potential hazards not shared by man and his domestic animals.

Clarification of Terms

As a prelude to any attempted evaluation of the hazards which may be inherent in the use of insecticides, a few frequently misused terms must be clearly defined. To avoid endless confusion, a careful distinction must be drawn between the terms hazard and toxicity. As the Food Protection Committee of the National Research Council has repeatedly pointed out: "Toxicity is the capacity of a substance to produce injury; hazard is the probability that injury will result from the use of the substance in the quantity and in the manner proposed." Therefore, to be at all reliable, an estimate of the hazard involved in the use of any substance must be based upon a knowledge of its inherent toxicity and upon the details of its proposed use.

It is also imperative to recognize and understand the equally clear-cut difference between the terms acute and chronic toxicity. In general, *acute toxicity* refers to toxic effects (either lethal or profound) occurring immediately after, or at least definitely attributable to, a single exposure by any route of administration, but usually referring to ingestion. *Chronic toxicity* refers to toxic effects resulting from repeated or multiple exposures extending over a period of time and is generally considered to be cumulative in nature.

As noted earlier, the hazards to man and his domestic animals resulting from approved uses for insecticides in public health and agricultural insect control programs have been extensively studied and the general sum and substance of all research in this field have failed to indicate any significant public health hazards. It is generally conceded that safety factors ranging from 10 to 100 fold have been included in most recommendations and at times such factors have been superimposed one upon another until the possibility that an actual hazard may exist is fantastically remote. Whereas man and his domestic animals are afforded much protection by the labeling requirements of the Insecticide, Fungicide, and Rodenticide Act of 1947, which specifies definite time-lapse intervals between insecticide applications and the harvest or consumption of the crop, it is generally recognized that most forms of wildlife can hardly be expected to avail themselves of such precautions. It is also recognized that fish, reptiles, amphibians, and numerous arthropods are more susceptible to insecticide poisoning than are mammals and birds, and in fact there have been a number of cases where fish were killed following the direct or inadvertent contamination of streams and lakes.

As a matter of fact, entomologists, toxicologists, and wildlife biologists alike recognize that some species of wildlife are subjected to hazards not encountered by man or by his domestic animals and thus they present special problems requiring special research attention. For example, it is well known that in general the food consumption of animals is more or less inversely proportionate to their size; thus birds, rabbits, and other forms of wildlife receiving the same diet as much larger animals actually ingest larger amounts of pesticidal chemicals in terms of mg/kg of body weight. Then too, in many treated areas the intake of insecticides by various forms of wildlife may be by ingestion, inhalation, or absorption, and under some conditions certain species may be subjected simultaneously to exposure by all three routes of administration. Finally, it is obvious that relatively small species moving in, around, and under a vegetative cover are subjected to greater and more prolonged exposure than are larger domestic animals standing well above the contaminated vegetation.

In view of the foregoing factors, it is not surprising that there have been numerous instances in which wildlife of varied types has been adversely affected by insecticides. At the same time, the preponderance of evidence to date indicates that such incidents can usually be traced to carelessness, to accidents, to instances of outright experimentation, or to non-agricultural programs involving anticipated hazards. Considering the thousands of tons of insecticides that have been used—and misused—in the control of agricultural pests during the last 50 years, it can be concluded that to date the impact of insecticide usage on wildlife has neither been great nor disastrous. This holds true for orchards, market gardens and cotton fields, which represent the most extensive and intensive agricultural usage of insecticides. Actually, considered from the broad point of view, the impact of agricultural and public health insecticide use on wildlife has been insignificant when compared with many of the other everyday activities of man.

In contrast to these remarkably safe agricultural practices, the existence of some very specialized insect control programs that call for per-acre insecticide dosage rates as much as 5 to 10 times those required in most agricultural uses must be recognized. These do involve calculated risks insofar as wildlife is concerned. The spraying of elms for the control of phloem necrosis or the Dutch elm disease, and the fire ant control program are examples. In such cases the interested parties must, or at least should, with the aid of competent experts, weigh the facts pro and con and then adopt a course of action that will best serve overall interests.

The Balance of Nature

Not infrequently insecticides are accused of upsetting the balance of nature, when in many instances it would be more accurate to say they were used to suppress an organism already out of balance. Actually, man himself has been the primary factor in upsetting the so-called natural balance. When he cleared the forest, plowed the prairies, drained a marsh, or dammed a stream, he altered an entire environmental complex and set up an entirely new set of opposing forces which if left uninhibited would establish an entirely new biotic equilibrium. Presumably it is obvious to all that nature's balance is not a static condition, but is rather a fluid condition changing from day to day, and at the same time constantly moving forward in response to the forces of changing geologic time and advancing culture. Insecticides represent only one minor element of these dynamic forces.

In nature, every living organism is engaged in the most ruthless kind of competition with every other organism upon which its interests impinge. Man is a part of that environment. That he has been eminently successful is evidenced by the fact that the human population of this country has risen from less than one million to over 170 million in some fifteen to twenty generations. It now becomes apparent that to clothe and feed this vastly increased population, man must maintain his position of dominance, and our agricultural production must continue to increase even at the expense of the further displacement of native plants and animals. It may be news to some that these pressures are now intensified by the fact that we have at last absorbed and brought into production most of the lands suitable for agricultural production. As a matter of fact, 1954 marked a turning point in our history because then for the first time the withdrawal of agricultural land for use as home or industrial sites, airports, and highways exceeded the land reclaimed, and the number of acres in farms showed a decline. While America is pleasantly blessed or, as some say, plagued, by overproduction, with populations increasing and the area of farm land trending downward, it will be a matter of only a few years until agricultural scientists and farmers will have to make ever-increasing use of new advances in agricultural technology, including even greater use of insecticides and other pesticides, to meet the nation's food and fiber requirements.

Population and Land Use

In a recent discussion of population dynamics and land use problems, H. B. Mills (9) said, "When we think of the future of recreational lands in all of this competition for land use, we cannot get away from zoning. We must think of areas where people will live, where they will work, where their roads will go, where they will produce their food, where they can find outdoor relaxation, and where wildlife can live and prosper. We may not like the idea of such regimentation; it will be an expression of restricion of personal freedom due to increased population density."

In 1954, the United States Department of Agriculture (11) estimated that to offset the pest losses in agricultural production, an extra 88 million acres must be cultivated, and that losses subsequent to harvest equal the production of an additional 32 million acres. Is it not possible that the benefits to be derived by diverting these acres to soil and wildlife conservation would far exceed any forseeable damage that might accrue from the approved use of insecti-

cides? The recent amendment of the duck stamp law is a step in the right direction, but this is apparently not enough. There is still some talk of a land bank, and the disposition of submarginal lands is still an open question. But 10 years hence may be too late. Is it possible that while dissipating our energies pondering potential hazards that may never materialize, we are missing the opportunity of a lifetime to secure and preserve an adequate representation of our native fauna and flora to be forever maintained in suitable conservation and recreational areas?

Difficulties of Evaluation

Those familiar with the excellent reviews on wild-life-insecticide relationships by Brown (2), Rudd and Genelly (10), and Cope and Springer (3) must be aware of the fact there is a considerable volume of excellent field and laboratory research, much of which tends to pinpoint areas of considerable concern where further research is needed. Nevertheless, at times it is difficult to evaluate properly many of the criticisms directed against insecticides and certain insect control practices. For example, some authors frequently note that a certain insecticide such as aldrin or heptachlor, is 5, 10, or even 20 times as toxic as DDT and then, after commenting in a matter-of-fact way that it may persist for several years, they imply that the hazard involved is tremendous, when actually the hazard may be insignificant because the dosage is low and the residue is rapidly lost. All too often the results of some laboratory or field experiments are cited as if they were typical of conditions to be encountered following the legitimate use of the insecticides without any further detail. Some attempt should be made to distinguish between the treatment of a million acres of cotton with X insecticide at 2 ounces per acre, and an equal area of marsh or timberland at 2 pounds per acre. A million acres is a lot of ground, but, after all, it represents considerably less than 1/10 of one per cent of the land area of the United States.

Pre-testing Insecticides

It is frequently asserted that new insecticides are introduced and released for large-scale insect control operations without adequate pre-testing, but apparently these critics are unaware that as early as 1948, Dr. A. J. Lehman (8) clearly and with amazing accuracy set forth the toxicological characteristics of DDT and related compounds. Then, too, the very fact that the review by Rudd and Genelly (10) contains a bibliography in excess of a thousand titles would indicate that the characteristics of insecticidal chemicals are not entirely unknown. As a matter of fact, there are experts who would testify that few if any chemicals known to man have undergone the toxicological scrutiny to which DDT has been subjected. It is true that all questions and problems have not been entirely resolved "beyond a shadow of a doubt," but that is not surprising, for after all, science is seldom if ever static and there are few instances where a scientist can claim he has established all of the answers finally, conclusively, and irrevocably.

Actually, there are many problems related to insecticidal chemicals that cannot be anticipated or resolved in advance in any laboratory or small plot experiments. As a matter of fact, in establishing the principles to be observed in the evaluation of new insecticides, the Food Protection Committee of the National Research Council (5) acknowledged this basic truth when it said, "Complete knowledge of many factors pertaining to pesticide usage, performance, and ultimate safety can be developed only through actual use in large scale performance tests. Hence, any system proposed for regulating the distribution of new materials should provide for their orderly release with recognized steps between strictly controlled small plot experiments and full scale commercial operations." This being the case one must anticipate certain adverse reactions and responses in the early large-scale usage of a pesticide. The correct procedure is to make sure such instances are detected and corrected as soon as possible. While the occurrence of such incidents is disturbing and regrettable, it seems reasonably certain the adverse effects will rarely if ever be disastrous or permanent.

Not infrequently the wildlife specialist and the conservationist feel that they are placed at a disadvantage in presenting their case because in a large degree the values with which they deal are intangible, and thus the reconciliation of divergent points of view which often elicit strong emotional responses becomes doubly difficult. Even here, there are at least some entomologists who can lend a sympathetic ear, for insect control also has its intangible considerations which can likewise induce violent emotional eruptions.

Many of the most dreaded diseases of man are insect-borne, and there are those who regard the continued control of insect disease vectors as essential to the maintenance of successful public health programs. The hundreds of phone calls that besiege public health officials when nuisance mosquitoes become annoying lend ample testimony to the public interest in and the demand for local mosquito control programs.

Fig. 42. Elm trees killed by Dutch elm disease. Tree lovers insist this should not have been permitted; bird lovers insist trees should not be sprayed if birds and other wildlife may be adversely affected. Photo, Illinois Nat. Hist. Survey.

Then, too, a large segment of the American public is profoundly interested in the protection of shade trees, ornamental plantings, and forests. Literally thousands of individuals, recalling with profound regret the demise of the chestnut tree because no effective disease control measures were available, vociferously demand that every possible effort be made to assure that the same fate does not befall the American elm, the most common and perhaps the most beloved shade tree in America. In the battle for the elms we approach the tragedy of civil war, for here we have entomologist pitted against entomologist, conservationist against conservationist, and neighbor against neighbor. Last but not least, the fact that the Congress of the United States and a score of state legislatures, normally reluctant to appropriate funds, except in response to great pressure, have approved plans and appropriated funds for several large-scale insect control programs, testifies to the public's interest in phases of insect control which do not affect its diet and only indirectly affect its pocketbook.

Considering All Sides

Any fair and impartial appraisal of the impact of insecticides on wildlife must give equal consideration to both the good and bad side-effects that may occur, and if we are to be honest we must look for the good as diligently as we look for the bad. Unfortunately, harmful side-effects are usually readily apparent, whereas indirect beneficial results are apt to pass totally unobserved. Nevertheless, the impartial observer may be pardoned if he considers the loss of a few song birds attributable to the spraying of elm trees less harmful than the permanent loss of such trees, with the accompanying disappearance of nest sites. (Fig. 42)

Unfortunately, the ultimate effect of insecticide usage on animal life cannot always be measured in terms of initial mortality of individual species. In reality it must reflect and encompass the long-term effects on both plant and animal life. Since the latter is largely dependent upon plants for both food and shelter, is it not possible that the destruction of timber, range vegetation, or cultivated crops by insects may produce a chain reaction that will ultimately affect all of the forms of life in the area?

Conclusions

There is no question but that the future food, fiber, and public health needs of this country will assure the continued, if not, indeed, the greatly expanded use of insecticides for generations to come.

Despite the widespread use of insecticides totaling billions of pounds in the last decade, fearful predictions that the large-scale usage of modern pesticidal chemicals would seriously upset the balance of nature and result in disastrous losses of wildlife have not been realized. To quote from the most comprehensive and complete study of the problem (10), "Considered in its broadest scope, at the present time pesticides seem to be only minor influents in nature compared to other factors in land and water development and use."

Favorable results notwithstanding, the many diverse and complex problems of wildlife conservation in a chemical world must be kept under continued surveillance. Particular attention should be devoted to the welfare of rare species of restricted habitat, to the impact of new chemicals as they are introduced, and to pest control programs involving the widespread application of insecticides over large contiguous areas.

Since most of the unfortunate incidents, problems, and differences of opinion that have arisen or are likely to arise, involve insecticide usage (unintentional or otherwise) that was not covered by label approval, it appears that the solution of the problem at hand rests in the detection, isolation, proper evaluation, and eventual elimination of malpractices rather than indulgence in wholesale condemnation of insecticides and insecticide usage *per se*.

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